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## IMPACT CONTRIBUTION OF PREBIOTIC REACTANTS TO EARTH

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Prepared for

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Ames Research Center  
Moffett Field, California 94035

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16. Abstract A study was performed to explore the effectiveness of comets for chemical evolution. The concentration of amino acids in various terrestrial environments was mathematically explored, because there is evidence that amino acids formed as a result of cometary impact. First, the initial concentration of amino acids in surface environment after cometary impact was estimated. The effect of hydrothermal vents, ultra-violet rays, and clays was taken into consideration. Next, the absorption of amino acids by clay particles before degradation by ultra-violet light was analyzed. Finally, the effectiveness of clays, ultra-violet and hydrothermal vents as sinks for cometary amino acids was compared. A mathematical model was then developed for the production of impact deposits on Earth for the past 2 Ga, and the relative thickness distribution was computed of impact deposits produced in 2 Ga. The reported relative thickness distribution of tillites and diamictites of all ages agrees with the thickness calculated from this impact model. This suggests that many of the ancient tillites and diamictites could be of impact origin. The effectiveness of comets was explored on the chemical evolution of amino acids. The effect of sinks such as clays, submarine vents, and uv light on amino acid concentration was considered. Sites favorable to chemical evolution of amino acids were examined, and it was concluded that chemical evolution could have occurred at or above the surface even during periods of intense bombardment of the Earth more than 3.8 billion years ago.			
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# **IMPACT CONTRIBUTION OF PREBIOTIC REACTANTS TO EARTH**

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During the first performance period (4/1/91 - 12/31/91), a study was performed to explore the effectiveness of comets for chemical evolution. Although many organic compounds must have been required to originate life, a mathematical analysis was performed of the concentration of amino acids in various terrestrial environments, because there is evidence that amino acids formed as a result of cometary impact. First, the initial concentration of amino acids in surface environment after cometary impact was estimated, because this was critical to the process of evolution. The effect of hydrothermal vents, ultra-violet rays, and clays was taken into consideration. Next, the absorption of amino acids by clay particles before degradation by ultra-violet light was analyzed. Finally, the effectiveness of clays, ultra-violet and hydrothermal vents as sinks for cometary amino acids was compared.

During the second performance period (1/1/92 - 2/28/93), a mathematical model was developed for the production of impact deposits on Earth for the past 2 Ga, and the relative thickness distribution was computed of impact deposits produced in

2 Ga using the known limits of depth vs. diameter ratios of impact craters and other variables, including empirical descriptions of impact ejecta thickness. The model gives both the maximum fractional area of Earth covered with ejecta, and the maximum ejecta thickness. Literature search yielded that the relative thickness distribution of tillites and diamictites of all ages agreed with the thickness calculated from this impact model. This suggests that many of the ancient tillites and diamictites could be of impact origin.

As another part of this second-year research effort, the effectiveness of comets was explored on early steps in the chemical evolution of amino acids. The initial concentration of amino acids in aqueous surface environments after comet impacts was first estimated, and then the effect of sinks such as clays, submarine vents, and ultra-violet light on amino acid concentration was evaluated. Sites favorable to chemical evolution of amino acids were examined, and it was concluded that chemical evolution could have occurred at or above the surface even during periods of intense bombardment of the Earth more than 3.8 billion years ago.

The research was performed in close scientific collaboration with the NASA Technical Officer, Dr. Verne R. Oberbeck, of Ames Research Center, Moffett Field. It resulted in the following publications:

(1) Verne R. Oberbeck and Hans Aggarwal, *"Comet Impacts and Chemical Evolution on the Bombarded Earth,"* *Origins of Life and Evolution of the Biosphere* 21, 317-338, 1992.

(2) H.R. Aggarwal and V.R. Oberbeck, *"Mathematical Modeling of Impact Deposits and the Origin of Tillites,"* 1992 Meeting abstract.

(3) Verne R. Oberbeck, John R. Marshall, and Hans Aggarwal, *"Impacts, Tillites, and the Breakup of Gondwanaland,"* *The J. of Geology*, 101, p. 1-19, 1993.